

**TAILTWISTER-D
ROTATOR SYSTEM**

**INCLUDING THE DCU-1 "PATHFINDER"
DIGITAL CONTROL UNIT**

hy-gain®

T2XD

TAILTWISTER-D ROTATOR SYSTEM

**INCLUDING THE DCU-1 "PATHFINDER"
DIGITAL CONTROL UNIT**

hy-gain®

NOTICE:

All rights in this publication are reserved. No part of the publication may be reproduced in any manner whatsoever without the expressed written ~~permission~~.

TABLE OF CONTENTS

	Page
CHAPTER 1 - Installation and Operation	1-1
Section 1. Components of the T2X-D	1-1
General	1-1
Section 2. Specifications	1-2
Section 3. Precautions	1-4
Section 4. Installation Preparations	1-5
Types of Installations	1-5
Precautions	1-8
Section 5. Wiring and Check-Out	1-9
Section 6. Installing the Rotator	1-11
Inside Tower Mount	1-11
Outside Tower Mount	1-13
Mast Mount	1-13
Section 7. Optional Accessory Kits	1-14
Section 8. Operation of DCU-1 Pathfinder Control Unit	1-15
Precautions	1-15
Normal Operation	1-15
Computer Operation	1-16
Section 9. Troubleshooting	1-18
Ground Wires	1-19
Antenna Motion	1-19
Lack of Power	1-19
Checking the Control Unit Voltages	1-20
Checking the Rotator Resistances from the Ground	1-20
Section 10. Disassembly of the Rotator Unit	1-21
Spur Gear Assembly	1-22
Section 11. Reassembly of the Rotator	1-23
Section 12. T2X Rotator Replacement Parts	1-24
Section 13. DCU-1 Control Unit Block Diagrams	1-29
Section 14. DCU-1 Control Unit Replacement Parts List	1-30

LIST OF ILLUSTRATIONS

Figure		Page
1	Front View	1-3
2	Back View	1-3
3	Rotator Mounted Inside	1-5
4	Rotator Mounted on Tower Top Plate	1-6
5	Pole Mounted Rotator	1-7
6	Control Cable Connector Attachments	1-9
7	DCU-1 Display	1-10
8	Rotator Mounting in a Tower.....	1-11
9	Rotator Mounting with (optional) Lower Mast Support.....	1-14
10	Wiring Guide	1-16
11	Command Set.....	1-16
12	Sample Program	1-17
13	Spur Gear Assembly	1-22
14	Inside View of T2X Rotator.....	1-25
15	Brake Assembly and Terminal Board Wiring Detail	1-26
16	T2X Rotator-Illustrated Parts Breakdown	1-28
17	Front Panel PCB, Block Diagram	1-29
18	Control PCB and External Components, Block Diagram	1-29

LIST OF TABLES

Table		Page
1	Control Cable	1-9
2	Troubleshooting	1-18
3	Control Unit Voltages	1-20
4	Rotator Resistances	1-20

CHAPTER 1

INSTALLATION AND OPERATION

Section 1. Components of the Tailtwister - D

General Description

The Tailtwister - D rotator system consists of an extra heavy duty rotator and the new DCU-1 "Pathfinder" digital control unit. The rotator is designed to be mounted on a plate inside a communications tower, and is attached to a vertical steel antenna mast. This is the recommended mounting method. The DCU-1 control unit must be installed indoors and connected to the rotator by an 8 conductor cable.

The DCU-1 "Pathfinder" digital control unit features 6 memory presets, automatic brake delay (8 seconds), automatic motor slowdown (last 5 degrees), automatic motor control on startup, programmable center of rotation, full circle analog display of current and target bearings, digital display of current and target bearings, automatic display blanking of target bearings (30 seconds), automatic display blanking (30 minutes), RS-232 control with pass-through, and an 8 pin socket for the control cable.

The Tailtwister rotator features low temperature operation (-30 deg. F/ -34 deg. C), a weatherproof AMP connector with gold-plated contacts, an improved high-strength steel drive gear, RF beads on the potentiometer lines, wedge brake, and safe 26 volt operation.

The rotator unit must be connected to the control unit with an 8-wire cable. You may assemble your own cable from the information supplied in this manual, or you may purchase pre-assembled cables from a dealer.

The Tailtwister-D rotator system consists of the following main components:

P/N 5137701	T2X Rotator Assembly
P/N 870804	DCU-1 Control Unit Assembly (120 VAC)
P/N 870842	DCU-1 Assembly Control Unit (220 VAC)
P/N 870843	Parts Pack Connectors (220 VAC)
P/N 870598	Parts Pack, Connectors (120 VAC)
P/N 5142210	Parts Pack, Mounting Hardware

It is recommended that you use this rotator system with compatible antennas and towers. For example, the maximum antenna size for this system is 20 sq. ft. (1.86 sq. m). Therefore, if you anticipate using antennas near this limit, the tower system should also be rated for wind areas of this magnitude. If you are considering antennas with long booms and/or long elements, do not exceed the Effective Moment specification of 3400 ft. lb. (470 Kg. m.). EM is defined as the antenna turning radius times weight. Antennas with long booms and elements have much more angular momentum and exert more torque on rotator systems than antennas with shorter booms and equal areas.

Options:

The optional heavy-duty lower mast support kit must be used if you elect to use a mast mount (see Figures 5 and 9). The part number for this kit is 5146710. When using the lower mast support, the antenna size is restricted to 10 square feet of wind area. The "inside tower mount" configuration is recommended (see Figure 3).

Section 2. Specifications

Specifications

Electrical:

Input voltage..... 120 VAC 50/60 Hz, 3 Amp max
(or 220 VAC 50/60 Hz, 1 Amp max)
Motor..... 24 VAC, 2.25 Amp, capacitor start/run
Brake Solenoid..... 24 VAC, 5 Amp
Power Transformer..... 120 VAC/26 VAC 10% duty, thermal switch protected
(220 volt model has 220 VAC/26 VAC 10% duty, thermal switch protected)

Maximum Cable Resistances:

Pins 1 and 2 0.8 ohms
Pins 3 - 8..... 2.0 ohms

Rotator Mechanical:

Maximum Antenna Size:

Inside Tower Mount:

Wind Surface Area 20 sq. ft. (1.86 sq. m.)
*Effective Moment..... 3400 ft. lb. (470 Kg. m.)

Outside Tower Mount:

Wind Surface Area 10 sq. ft. (0.93 sq. m.)
*Effective Moment..... 1500 ft. lb. (207 Kg. m.)

Rotator Size 9" x 14.1" (O.D. x H)
(23.7 x 35.7 cm)

Antenna Mast Size 1.875 - 2.063" O.D. (48-52 mm)

Operational Temperature Range -30 deg F to +210 deg F
(-34 deg C to +99 deg C)

Brake positive, electrically operated wedge
60 segments, 6 degrees apart

Rotation time 50-65 seconds for 360 degrees

Mounting Hardware stainless steel bolts and nuts
plated steel clamp

* Effective Moment is defined as the antenna turning radius times the weight.

DCU-1 Digital Control Unit:

Size	8.5" x 4.3" x 9.0" (W x H x D) (21.6 x 11.0 x 22.8 cm)
Control Unit Display:	
Type	Gas Plasma, Amber filter
Scale	5 degree (Analog), 1 degree (Digital)
Blanking	Target Bearing (30 seconds) Total (30 minutes after no activity)
Display Life	30,000 to 40,000 hours
Memory Presets	6, independently programmable
Rotation Center	User selectable, 0 - 360 degrees
Brake Delay	8 seconds, fixed
Automatic Motor Control	-momentary reverse direction on startup -automatic stop if no rotator movement detected in 8 seconds -motor pulse (half-cycle)on last 5 degrees before stop,
Front Panel Controls	1 Knob (24 pos. digital encoder) - sets target bearing - sets center of rotation in calibrate mode 6 Memory Preset (pushbuttons) 1 Start Rotation (pushbutton) -also starts EPC (calibration) 1 Stop Rotation (pushbutton) 1 Display (pushbutton) - turns on display after blanking - enters calibration mode
Rear Panel Items	1 8-pin socket (rotor cable) 1 RS-232 Host (DB9F) 1 RS-232 Ext. (DB9M) 1 ground terminal (1/4"-20) 1 fuse holder 1 Power Cord, 3 wire

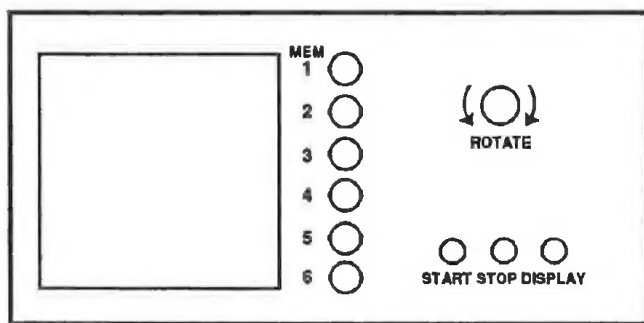


Figure 1
Front View

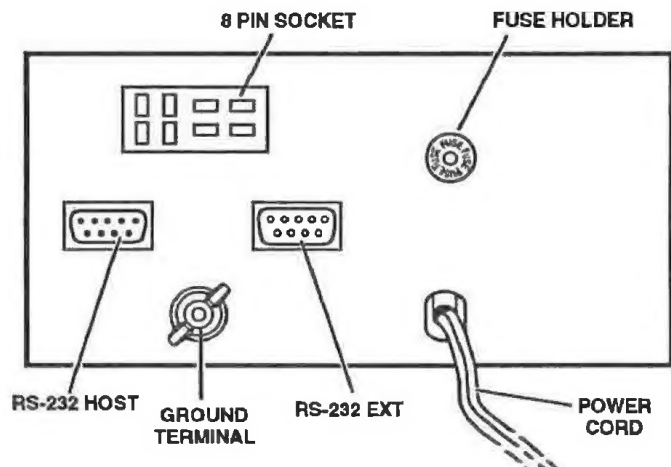


Figure 2
Back View

Section 3. Precautions

Towers and antennas require caution during erection and placement! Extreme care must be taken during erection so that metal tower and antenna parts DO NOT contact power lines, even if the parts slip, rotate, retract, fall or fracture!

Antenna position mechanisms (towers and rotators) must be placed so that if they fail, the parts of the antenna system cannot contact power lines, be a hazard to individuals, or endanger property.

Metal towers must be grounded properly at the tower location before the tower is erected. This is to minimize electrical hazard and the possibility of lightning damage. DO NOT bury bare aluminum wires or stakes in the ground. Use copper or copper-clad ground stakes. The service entrance ground should be checked. The household convenience outlet should be the 3-prong type (grounded back to the service entrance).

The DCU-1 Control Unit is not weatherproof and must be located in a house or other protected location. Do not allow the ambient temperature to exceed 130°F. Connect a ground wire to the 1/4"-20 terminal on the back of the DCU-1.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

The Tailtwister-D rotator system has been carefully designed and manufactured to give many years of trouble-free service when carefully and professionally installed. It consists of the strongest and best commercially available components. This product is manufactured in the U.S.A.

Section 4. Installation Preparations

Types of installations:

There are three general types of rotator installations (see Figures 3, 4, and 5).

1. The recommended installation is an "inside" tower mount with a thrust bearing or bushing to provide vertical and horizontal support. The thrust bearing should mount on the top surface of the tower and should fit the size of mast you are using.

The rotator shelf should be at least three (3) feet below the thrust bearing. If a single antenna is mounted on the mast, it should be no more than one (1) foot above the thrust bearing. The thrust bearing should be of commercial manufacture and should properly fit the tower that it is attached to. If your installation follows these guidelines, this rotator system will easily handle an antenna system of 20 sq. ft. wind area or EM of 3400 ft. lb.

ANTENNA OR BEAM—NOT TO EXCEED
20.0 SQ. FT. (1.86m²) WIND SURFACE
AREA LOAD

ANTENNA COAXIAL CABLE;
LOOP TO PERMIT FULL 360°
ROTATION OF BEAM
(DO NOT USE BELDEN 9913)

8-WIRE CONTROL CABLE

THRUST BEARING

TAILTWISTER

BASE PLATE
(PART OF TOWER)

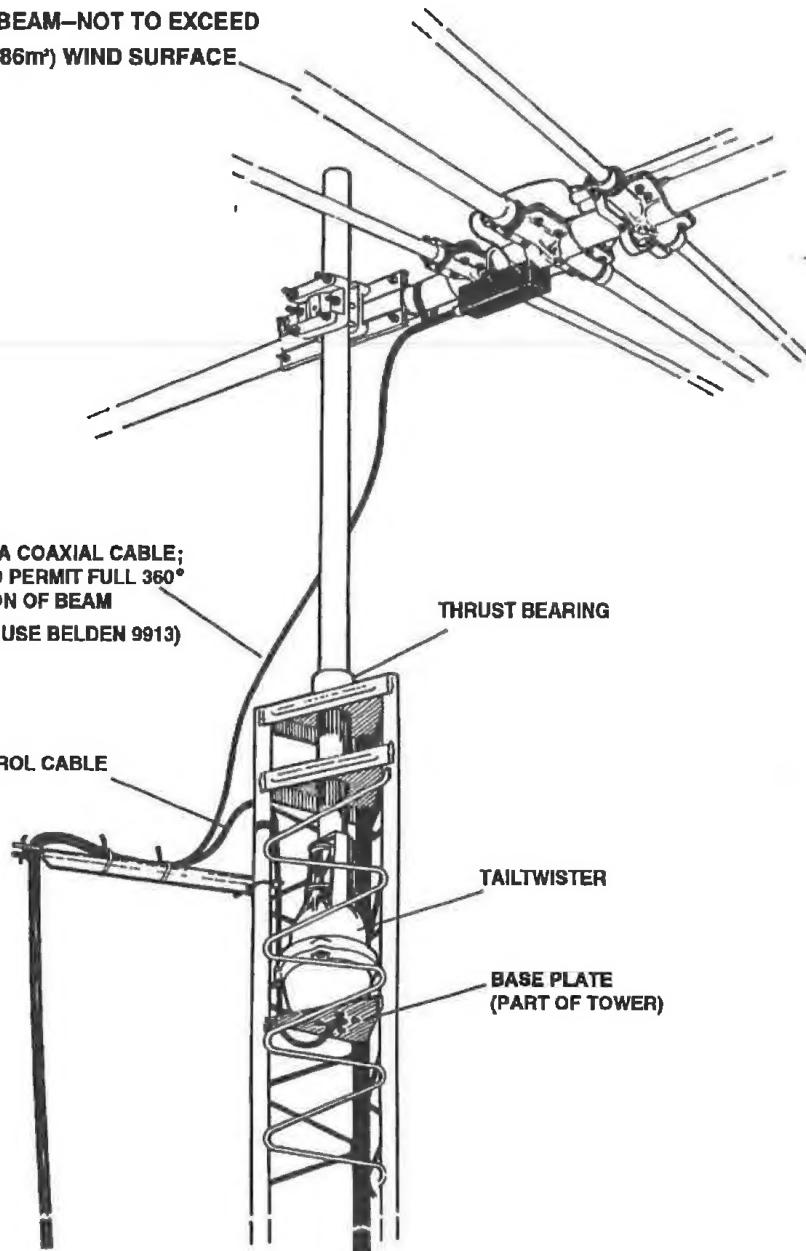


Figure 3
Rotator Mounted Inside

2. An "outside" tower mount may be used when the rotator unit will not fit within the tower, or there is no rotator shelf provided. In this installation, the rotor mounts on a flat plate at the top of the tower. There is no thrust bearing.

In this application, it is extremely important that the antenna is mounted no more than six (6) inches above the top of the rotator. If these guidelines are followed, the rotator system will easily handle a single antenna with a 10 sq. ft. wind area or EM of 1500 ft. lb.

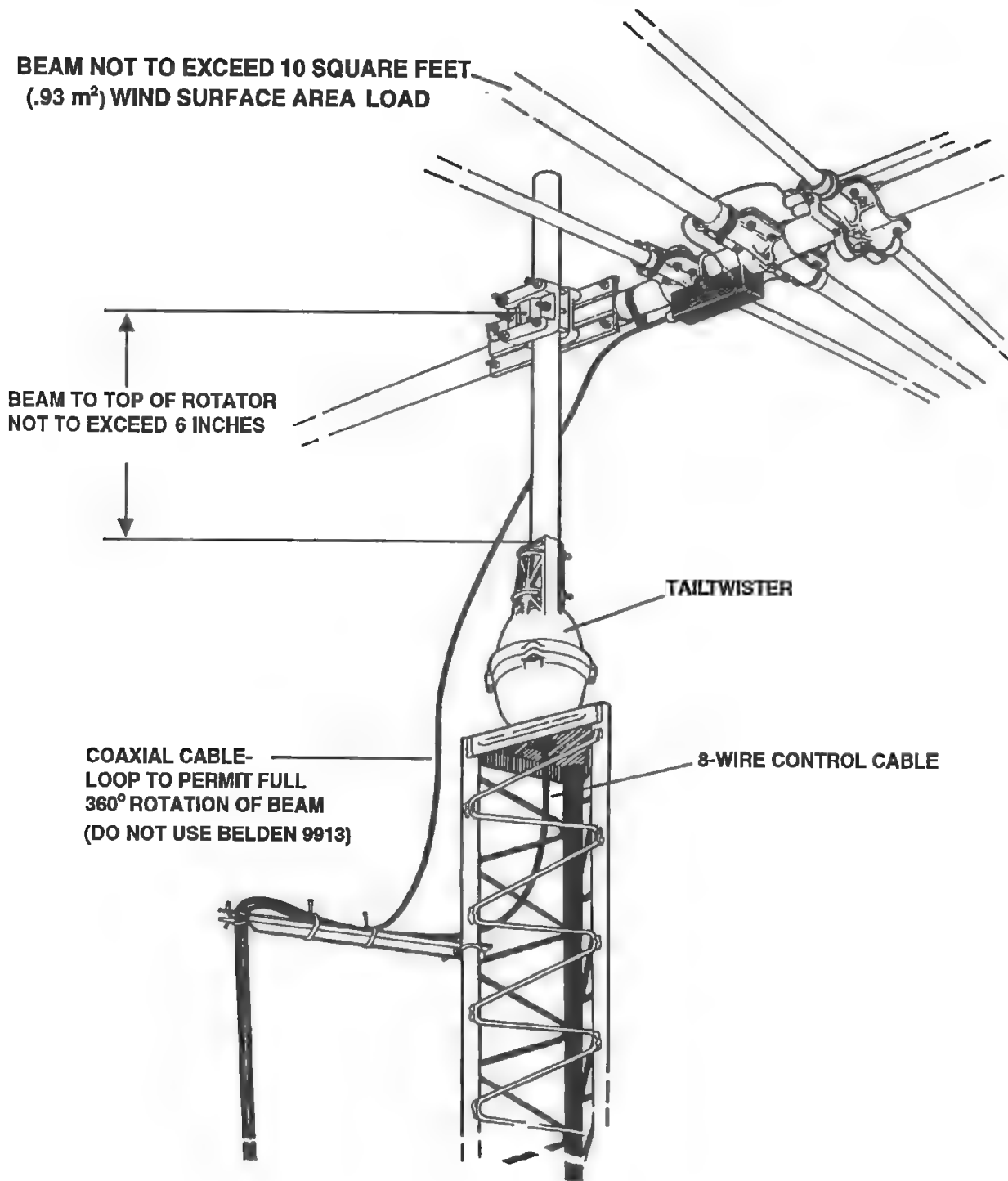


Figure 4
Rotator Mounted on Tower Top Plate

3. A telescoping or other type mast may also be used. This installation requires the optional "Heavy Duty Lower Mast Support Kit". In this application, it is extremely important that the antenna is mounted no more than six (6) inches above the top of the rotator.

If these guidelines are followed, the rotator system will easily handle a single antenna with a 10 sq. ft. wind area or EM of 1500 ft. lb. Ensure that the mast is also rated for this load!

There are variations of mounting which fall generally into one of the above categories. For example, the rotator may be mounted much lower in the tower than described. In this case, more than one mast bearing may be required.

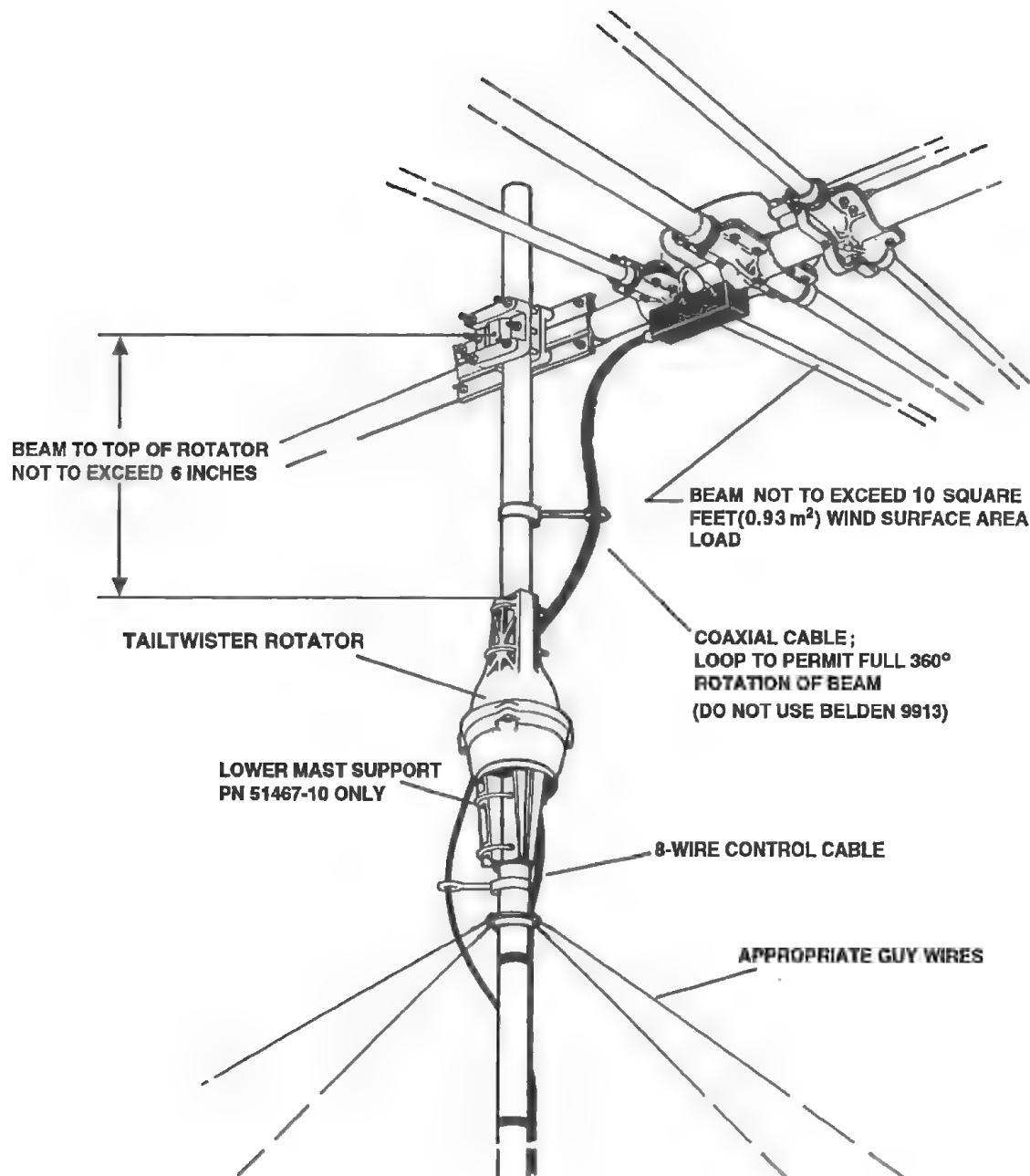


Figure 5
Pole Mounted Rotator

Precautions

1. **Unbalanced weight:** Weight should be as closely balanced as possible. Unbalanced weight in an antenna creates a bending moment of force which is concentrated on the mast at the point where it is clamped to the rotator.
2. **Wind Pressure:** Balanced wind pressure against the antenna system produces a bending force on the mast which can cause the same stresses as unbalanced weight. To minimize these forces, a thrust bearing should be used where possible, the antenna should be as close to the top of the tower as possible and the rotator shelf should be as low as possible.
3. **Unbalanced Wind:** If the antenna has unequal wind areas and element spacings on each side of the mast attachment point, it could produce torque on the support mast. This is similar to the principle of a weather vane. If the unbalance is high enough or the wind velocity is high enough, this could prevent rotation or could damage the limit switches. To minimize this effect, the antenna should be designed for minimum mast torque or "torque compensators" added to produce minimum mast torque.
4. **Mast Binding:** If the antenna support mast binds within the tower due to ice accumulation or other reasons, this could prevent rotation.
5. **Extreme Cold:** If the ambient temperature is at or below -30 degrees F, this could prevent rotation. If no movement is detected within 8 seconds of pressing "START", then the rotator will stop.

Section 5. Wiring and Check-Out

Wiring and Check-Out

1. Determine the length of control cable required and find the wire gauge (size) required from Table 1.

Maximum Length	Gauge for Terminals 1 & 2	Gauge for Terminals 3-8
125' (38 m)	#18 (1.19 mm)	#20 (.97 mm)
200' (61 m)	#16 (1.42 mm)	#18 (1.19 mm)
300' (91 m)	#14 (1.75 mm)	#16 (1.42 mm)

Recommended Cables

Belden 8448

Belden 9405

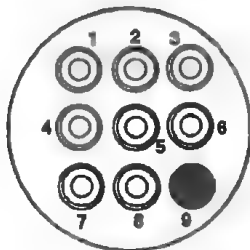
IEWC #8612

TABLE 1

NOTE: The specifications call for heavier gauge wire in two locations. Leads #1 and #2 must be heavier gauge and less total lead resistance.

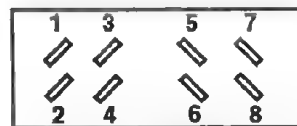
2. Assemble the rotator cable as shown in Figure 6, or purchase a pre-assembled cable.

**9 PIN CONNECTOR
FOR ROTATOR END
OF CONTROL CABLE**

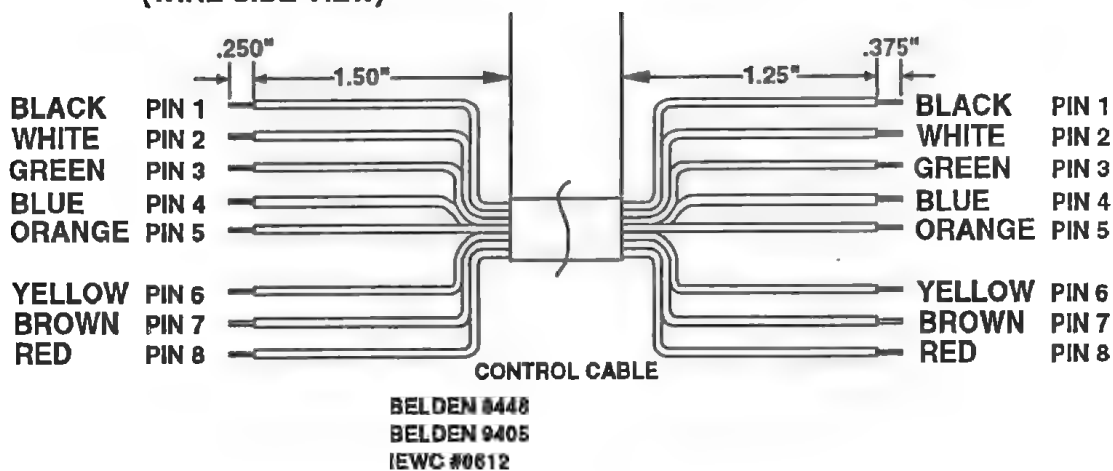


(WIRE SIDE VIEW)

**8 PIN CONNECTOR
FOR CONTROL CONSOLE
END OF CONTROL CABLE**



(SOLDER SIDE VIEW)



**Figure 6
Control Cable Connector Attachments**

CAUTION

Shorts between terminals or grounded leads may damage the rotator. Check the numbered pins on each connector with an Ohmmeter! Pin 1 is connected to pin 1, etc.

3. Temporarily attach the 6 screws, 5/16" - 18 x 1 5/8", to the bottom of the rotor unit. These will be used to support the rotator during bench-testing.
4. With the rotator sitting in the upright position and connected to the control unit by the 8-wire cable, plug the control unit power cord into a receptacle. At this time, the rotator brake wedge may momentarily release and re-engage. This is normal.

5. The DCU-1 display should look similar to the display shown in Figure 7. The numeric display in the lower left corner indicates the current bearing of your rotator. The numeric display in the lower right corner indicates the target bearing. If both displays read a steady "000", disconnect your control cable and check the cable wiring with an ohmmeter.

NOTE: After approximately 30 to 45 seconds of inactivity, the target digital and analog displays will blank (disappear). After 30 minutes of inactivity, the entire display will blank. Push the "DISPLAY" button to return normal display.

6. If the current bearing display shows a number between "001" and "359", then proceed. Twist the knob marked with the two (2) arrows "↺↻". The target bearing display should change along with the inner circle tick mark. Using the knob, select a target bearing at least 30 degrees from the current bearing. Push the "START" button. The brake in the rotator should release, the rotator will turn a few degrees in the opposite direction, reverse direction, then turn to the target bearing. During the last 5 degrees, the rotator will slow down to half speed, then stop on or close to the target bearing. The brake solenoid will "hum" for 8 seconds, then the brake will engage. During rotation, the outer circle tick mark will move to the new bearing.
7. You may wish to repeat step 6 to confirm operation over a wide range of bearings. If the "STOP" button is depressed during rotation, rotation will stop and the brake will engage 8 seconds later. If the operation is consistent, proceed to the next step.

8. Decide on the mechanical center of rotation at this time. For example, if you would like to rotate from East to West through South, then South (180 degrees) is your center of rotation. The center of rotation can be selected as any bearing between "000" and "359". Press "DISPLAY" and hold until the letters "CAL" appear in the center of the display. The rotator should automatically turn to the mechanical center of rotation. When it has reached this position, the letters "SET" should appear in the center of the display. Twist the knob until the desired center of rotation is displayed in the lower right corner.

Press the "START" button and hold until the rotator starts to turn. The rotator will automatically find both limit switches and set up the calibration for the center of rotation you selected. During this time, the letters "EPC" will be displayed for "End Point Calibration". When this process is finished, the "EPC" will disappear, and the rotator is ready for use. If you wish, you may re-calibrate the rotator system at any time.

9. You may set the memory presets at this time or at any time after the rotator system has been installed. To store a bearing into a memory location, select a target bearing with the knob then press and hold the appropriate memory location button until the letters "PRE" lights up. You may use previously stored memory presets and the knob to select new bearings.
10. Rotate the system to the center of rotation. You are now ready to install the rotator system in your tower or on your mast.

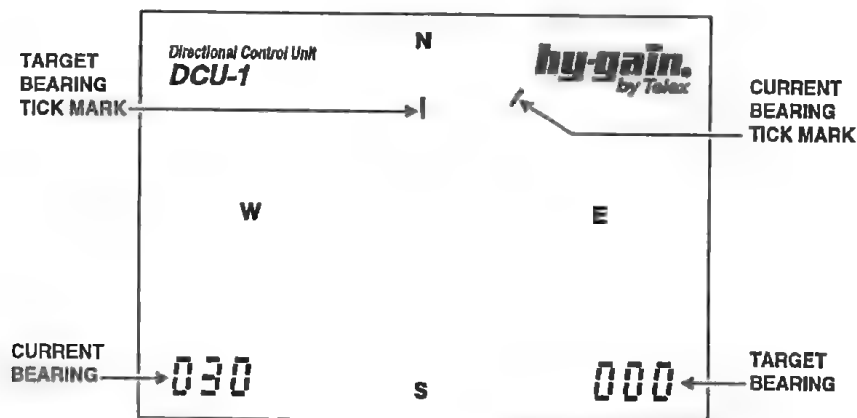


Figure 7
DCU-1 Display
1-10

Section 6. Installing the Rotator

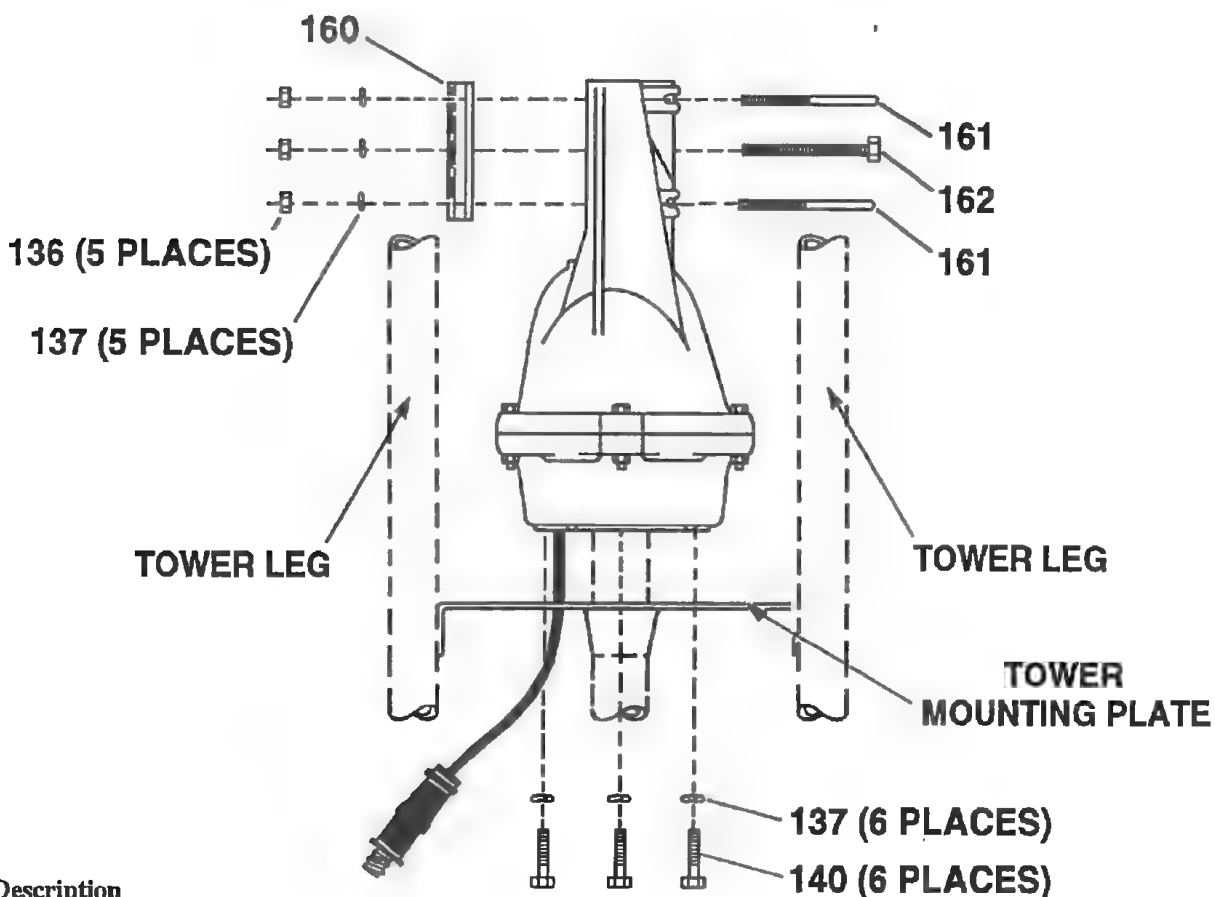
Installing the Rotator

Inside tower mount:

The rotator is mounted inside a tower, see Figure 3 and 8, to the flat tower plate by means of six (6) bolts furnished in the hardware kit. Use the following procedure:

1. Position the rotator in the tower directly under the thrust bearing. The tower plate must be cut out to allow the connecting 8-wire cable with connector to pass through the plate. If a new hole must be made, use the template in the back of this manual.

2. Attach the rotator to the tower plate by means of six (6) bolts and lockwashers (see Figures 3 and 8). The flat tower plate must be drilled in six (6) places using the template provided with this manual unless the tower plate is already properly drilled. Tighten the six (6) bolts.



Item No.	Description
136	Nut, hex, 5/16"-18, stainless steel
137	Lockwasher, 5/16", split, stainless steel
140	Bolt, 5/16"-18 x 1 5/8", hex head, stainless steel
160	Plate, Mast Clamp
161	U-Bolt, 5/16"-18 x 3 1/4" x 4"
162	Bolt, 5/16"-18 x 3 1/2", hex head, stainless steel

Figure 8
Rotator Mounting in a Tower

3. Attach the control cable to the rotator connector as before. Using the DCU-1 control unit, turn the rotator and observe rotator movement. If everything works properly, secure the cable to the tower using proper strain-relief techniques.
 4. Assemble the mast to the rotator using the U-bolts, nuts, lockwashers, and clamp plate as shown in Figure 8. Apply a coating of heavy-duty motor oil or grease to the threads of the stainless steel bolts and U-bolts to prevent seizing. Do not tighten at this time.
 5. Center the mast within the tower thrust bearing and secure the thrust bearing to the mast. Turn the mast by hand to check for binding within the tower. Adjust the thrust bearing if required. If no binding occurs, then tighten the rotator U-bolts to secure the mast to the rotator. Install and tighten the center mast bolt at this time. See Figure 8.
 6. Turn the rotator using the DCU-1 control. Observe mast movement throughout full 360 degree rotation. If any binding occurs, reposition the rotator on the flat plate and retighten the mounting bolts.
- CAUTION:**

Do not use masts with an O.D. less than 1 7/8" with a thrust bearing! It is important that the rotator does not try to turn the mast eccentrically within the top thrust bearing.
7. Position the rotator to the center of rotation using the DCU-1 control unit. Attach the directional antenna so that it points the same direction. The coaxial cable should be attached to the mast and tower so that the rotator can freely move in both directions to the ends of rotation. The coaxial cable should be flexible enough to permit rotation without damage. Do NOT use Belden 9913 cable in this rotation loop!

Outside Tower:

The rotator is mounted to the top surface of a tower, see Figure 4, by means of six (6) bolts furnished in the hardware kit. Use the following procedure:

1. Position the rotator on the top surface of the tower or other support structure and attach by means of six (6) bolts and lockwashers. The top of the tower must be cut out to allow the connecting 8-wire cable with connector to pass through the plate. If a new hole must be made, use the template in the back of this manual. Tighten the six (6) bolts.
2. Attach the control cable to the rotator connector as before. Using the DCU-1 control unit, turn the rotator and observe rotator movement. If everything works properly, secure the cable to the tower using proper strain-relief techniques.
3. Assemble the mast to the rotator using the U-bolts, nuts, lockwashers, and clamp plate as shown in Figure 4. Apply a coating of heavy-duty motor oil or grease to the threads of the stainless steel bolts and U-bolts to prevent seizing. Tighten all bolts securely.
4. Position the rotator to the center of rotation using the DCU-1 control unit. Attach the directional antenna so that it points the same direction. The coaxial cable should be attached to the mast and tower so that the rotator can freely move in both directions to the ends of rotation. The coaxial cable should be flexible enough to permit rotation without damage. Do NOT use Belden 9913 cable in this rotation loop!

CAUTION:

This rotator is designed for vertical operation with the bell-shaped housing pointing straight up. Do not mount this unit either horizontally or upside down.

Mast mount:

The rotator is mounted to a vertical mast, see Figures 5 and 9, by means of four (4) bolts and the optional lower mast support, P/N 5146710. Use the following procedure:

1. Attach the rotator to the lower mast support by means of four (4) bolts, nuts and lockwashers. Tighten the four (4) bolts. Attach this assembly to the top of the mast as shown in Figure 5. Tighten all bolts securely.
2. Attach the control cable to the rotator connector as before. Using the DCU-1 control unit, turn the rotator and observe rotator movement. If everything works properly, secure the cable to the mast using proper strain-relief techniques.
3. Assemble the top mast to the rotator using the U-bolts, nuts, lockwashers, and clamp plate as shown in Figure 8. Apply a coating of heavy-duty motor oil or grease to the threads of the stainless steel bolts and U-bolts to prevent seizing. Tighten all bolts securely.
4. Position the rotator to the center of rotation using the DCU-1 control unit. Attach the directional antenna so that it points the same direction. The coaxial cable should be attached to the mast and tower so that the rotator can freely move in both directions to the ends of rotation. The coaxial cable should be flexible enough to permit rotation without damage. Do NOT use Belden 9913 cable in this rotation loop!

NOTE: Belden 9913 Coax has a solid center conductor and an air-space dielectric. It is not flexible enough to use in a rotation loop.

Section 7. Optional Accessory Kits

Optional Heavy-Duty Lower Mast Support Kit PN 5146710

This kit contains a heavy-duty lower mast support and the necessary hardware to facilitate mounting the rotator on a mast.

CAUTION:

When the rotator is installed using the lower mast support kit, the antenna size must be restricted to 10 square feet (0.93 sq. m.) of wind surface area.

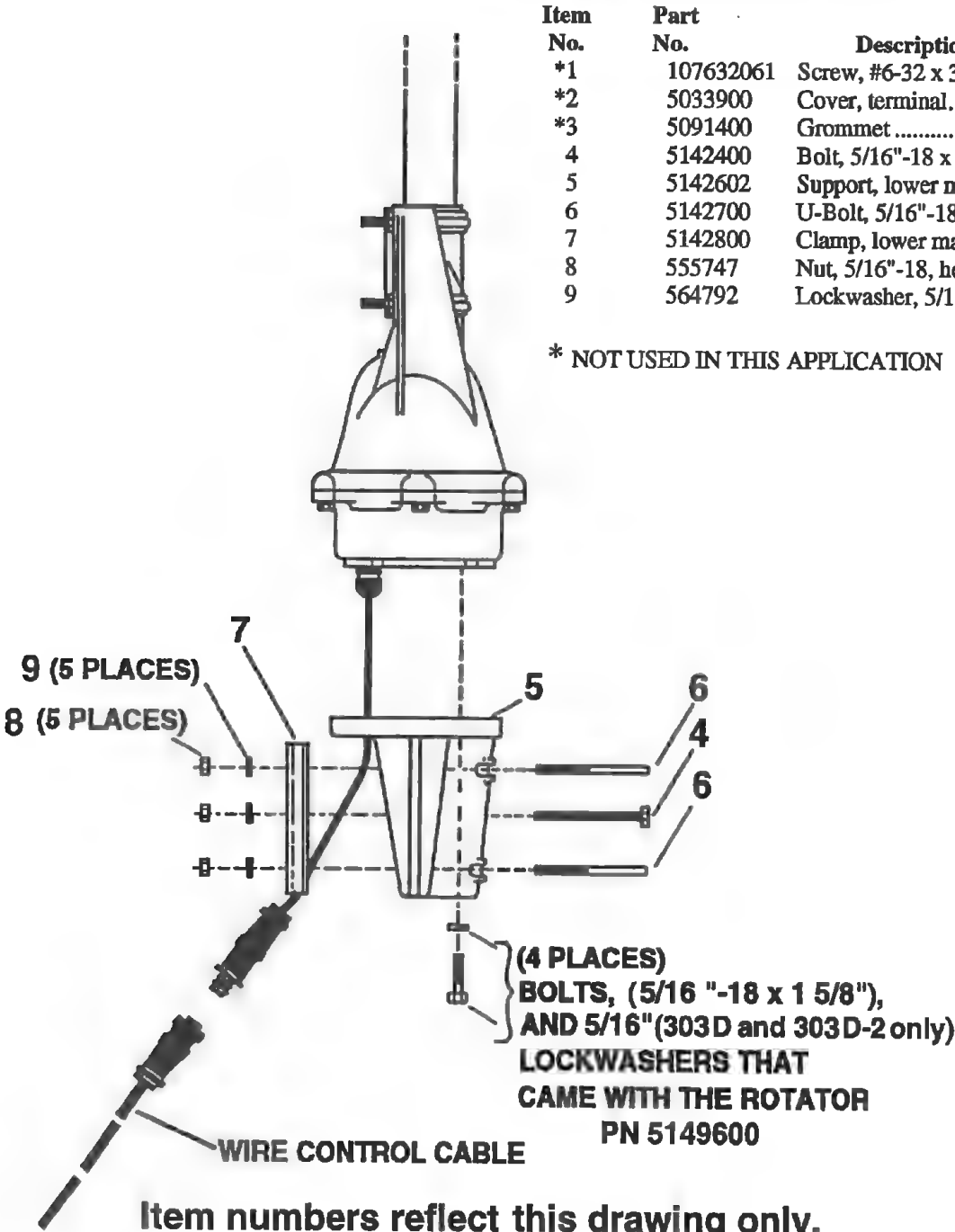


Figure 9
Rotator Mounting with (optional) Lower Mast Support

Section 8. Operation of DCU-1 Control Unit

Operation of DCU-1 Control Unit

Precautions:

1. **Thermal Protection:** If the rotator fails to turn after 4 or 5 minutes of continuous operation, the thermal switch has come into play. This protective device in the transformer assembly automatically shuts off power if the transformer becomes too hot. It will automatically reset after approximately 10 minutes.
2. **Display Protection:** The gas-plasma display will be turned off during periods of inactivity to extend its useful life. After approximately 30 to 45 seconds of inactivity, the target digital and analog displays will blank (disappear). After 30 minutes of inactivity, the entire display will blank. Push the "DISPLAY" button to return normal display.
3. **Brake Wedge Protection:** The brake wedge will only engage after waiting eight seconds after removing power from the motor. This allows large antenna systems to coast to a complete stop before engaging the brake. Even if the "STOP" button is pressed, the system will still wait eight (8) seconds before dropping the brake. The brake will immediately engage if AC power is disconnected from the control unit.

CAUTION:

Do not reverse rotation direction during rotation! This will cause the system to hang with the brake released. Pressing "STOP" will reset the system.

Normal Operation

The numeric display in the lower left corner and the outer circle tick mark always indicates the current bearing of your rotator. The numeric display in the lower right corner and the inner circle tick mark indicates the target bearing. This display is also used during calibration to select the center of rotation. The center alpha-numeric display is used during the calibrate routine and to indicate memory preset selections. The tick marks may fluctuate between two marks if the rotator is moving in the wind and the digital bearing ends with "2" or "7".

To move the rotator to a new bearing, either the knob, memory presets, or a combination of these may be used to select the new bearing. To start rotation to this new bearing, press "START". The brake in the rotator will release, the rotator will turn a few degrees in the opposite direction, reverse direction, then turn to the target bearing. During the last 5 degrees, the rotator will slow down to half speed, then stop on or close to the target bearing. The brake solenoid will stay on for 8 seconds, then the brake will engage. During rotation, the outer circle tick mark will move to the new bearing.

If the "STOP" button is pressed during rotation, rotation will stop and the brake will engage 8 seconds later.

To store a bearing into a memory location, select a target bearing with the knob then press and hold the appropriate memory location button until the letters "PRE" light up. These pre-sets are stored in non-volatile memory and will stay in memory even if the unit loses power. You may use previously stored memory presets and the knob to select new bearings to store.

NOTE: The rotator may end up a few degrees off the desired target bearing. This is because the brake wedge locks into place every six (6) degrees. This should not cause any problems in most HF and VHF installations.

Computer Operation

The DCU-1 may be controlled from your computer via a RS-232 cable connection. The rear panel has two (2) RS-232 connectors. The connector marked "HOST" is a DB9 female connector and should be directly connected to the host computer. Do not use a null-modem connection. The connector marked "EXT" is a DB9 male connector and should be connected to other ham equipment such as a modem, TNC, or radio interface unit. If the "EXT" connector is not attached to other equipment, it should be terminated with the supplied plug. The supplied termination plug shorts DTR,DSR and DCD (Pins 4, 6, 1) together and RTS and CTS (Pins 7 and 8) together.

The cable which is attached to the computer and to the DCU-1 should have a DB9 male connector at one end and either a DB9 female or DB25 female connector at the other end. The connections should be straight through, e.g. pin 1 to pin 1, pin 2 to pin 2, etc if both ends have 9 pin connectors. If a DB25 female connector is used to attach to the computer's COM1 or COM2 port, use the wiring guide shown in Figure 10. You may also purchase a pre-assembled cable from Hy-Gain to connect your computer to the DCU-1. Order either DCU-9P or DCU-25P cable assemblies.

	Signal Name	DB9 pin	DB25 pin
DCD	Data Carrier Detect	1	8
RX	Receive Data	2	3
TX	Transmit Data	3	2
DTR	Data Terminal Ready	4	20
GND	Signal Ground	5	7
DSR	Data Set Ready	6	6
RTS	Request to Send	7	4
CTS	Clear to Send	8	5
RI	Ring Indicator	9	22

Figure 10
Wiring Guide

Command:

Result:

AP1***;

Sets Target Bearing in DCU-1

(***is a three digit number between 000 and 359)

AM1;

Starts Rotation to Target Bearing

;

Resets system after any previous command

Figure 11
Command Set

The commands are similar to those used by Kenwood in controlling radio operations. A summary of unique commands is shown in Figure 11. The COM port should be used at 4800 baud with No parity, 8 data bits, 1 stop bit and ASCII mode. This is usually shown as "4800,N,8,1,ASC".

You may wish to check with our Customer Service Dept. from time to time in order to obtain the latest firmware upgrades.

1-17

Section 9. Troubleshooting

Troubleshooting

CAUTION: This unit has been thoroughly tested and cycled before shipment. Follow the connector wiring carefully between the rotator and the DCU-1 control box. Pin #1 must attach to Pin #1, etc... Incorrect wiring will burn out the rotator potentiometer and void the warranty.

The DCU-1 control box is designed to be used **ONLY** with Hy-Gain HAM-IV and T2X rotator systems. Do not try to use this control on other systems!

Problem	Possible Cause
Antenna Bearing doesn't match display	Mast slipped in rotator clamp Antenna slipped on mast DCU-1 Calibration not performed
Current Bearing changes randomly or does no change at all	Potentiometer broken or burned-up Shorts or opens in control cable Extremely high RF field near rotator DCU-1 MPU or A/D failure Tower or DCU-1 not grounded
Antenna Bearing changes by itself	Brake wedge failure DCU-1 MPU failure
Current Bearing changes +/- less than 3 degrees	Antenna rocking in high winds Potentiometer dirty or poor connection High RF field near rotator Long (200') control cable
Rotator unable to reach target bearing	Temperature less than -30 degrees F Broken teeth in gears Shorts or opens in control cable Thermal cut-out in power transformer Mast binding in tower Old motor-start capacitor High winds, high wind area Control cable wire size too small DCU-1 MPU failure
Rotator slow to reach target bearing	Temperature between -30 and 0 degrees F Broken teeth in gears Mast binding in tower Old motor-start capacitor High winds, high wind area

Table 2

Ground Wires

Most operational difficulties with rotators are traceable to broken, shorted, grounded or miswired control cables. Time spent on assembling, routing and protecting the control cable will lead to a long trouble-free rotator life.

Unintentional grounds on cable leads can burn out the line fuse in the DCU-1 control box, the A/D IC, or the potentiometer in the rotator. If pin #3 or pin #7 is grounded, it shorts out part of the potentiometer so that as rotation progresses to the other end, the full DC voltage is applied across a decreasing portion until current becomes so high that the potentiometer burns out. Note also that any grounds may put an overload on the power transformer which could cause the line fuse to blow.

Antenna Motion

Frequently the slight motion of the antenna array in gusts of wind is due more to the natural flexing of the elements and mast than to actual play in the rotator mechanism. A slight amount of "play" is built into the rotator to avoid binding due to environmental changes.

If the antenna actually rotates in high winds, this is usually just the mast slipping in the rotator or the antenna slipping on the mast. For large antennas, it is often necessary to drill a 5/16" hole through the rotator clamping plate and mast and pin them together with the bolt provided. Also, if possible, pin the antenna to the mast with appropriate hardware. If slipping is suspected, return the rotator to an end of rotation limit and visually check antenna alignment.

Lack of Power

If the antenna rotation is slow or sluggish or hard to start, check for proper voltages on pins #1,2,5, and 6 (See Table 3). If the voltages are correct, the 130 - 156 MFD capacitor may be old. If your unit is more than 5 years old, try replacing this capacitor. Also, if your cable run is over 200 feet, make sure that you are using the proper wire size. See Table 1. For cable runs over 300 feet, you may wish to move the motor capacitor to the tower. This allows you to run only 6 wires from the control to the rotator, so that you can reduce wire resistance by doubling up wires or using fewer, heavier wires.

If the electrical circuit is working, then check for mechanical problems. Look for mast binding or thrust bearing misalignment if you have experienced strong winds recently. If the temperature is less than -30 deg. F (-34 deg. C), the rotator will be very sluggish or may not run at all! This is normal. Do not try to rotate with the DCU-1 control if temperatures are below -30 deg. F !

Checking the Control Unit Voltages

To check the control unit voltages, first remove the rotator control cable from the DCU-1 control box, then plug the line cord into a 110 VAC outlet.

With no connections, the front panel display should read "180" on the current display and "000" on the target bearing displays. Check for the following voltages on the 8 pin connector:

NOTE:

You have 8 seconds after pressing "START" to make each measurement. The DCU-1 checks for movement, and after 8 seconds without movement, it stops trying to rotate. You may wish to make your meter connections with alligator clips, then press "START" when you are ready to read the meter.

Pin #'s	Ambient State	Press "START" (see note)
1 - 2	0	30 VAC
1 - 5	0	30 VAC
1 - 6	0	0
4 - 8	0	0
3 - 7	+ 5.0 VDC	+ 5.0 VDC

Table 3

Checking the Rotator Resistances from the ground

You may possibly avoid bringing the rotator down from the tower by making electrical resistance checks on the control cable. Disconnect the control cable from the control box. Check for the following resistances:

Description	Pin #'s	Approximate Resistance (ohms)
Brake Solenoid	1 - 2	0.75+ cable resistance
1/2 Motor Winding	1 - 8	2.5 +cable resistance
1/2 Motor Winding	1 - 4	2.5 +cable resistance
1/2 Motor Winding + switch	1 - 6	2.5 +cable resistance
Entire Motor	4 - 8	4.5 + cable resistance
Right Limit Switch	5 - 8	0 +cable resistance
Left Limit Switch	4 - 6	0 + cable resistance
Entire Pot	3 - 7	500 + cable resistance
Pot Arm to + End	1 - 3	0 to 500 (0 at full CCW)
Pot Arm to - End	1 - 7	0 to 500 (500 at full CCW)

Table 4

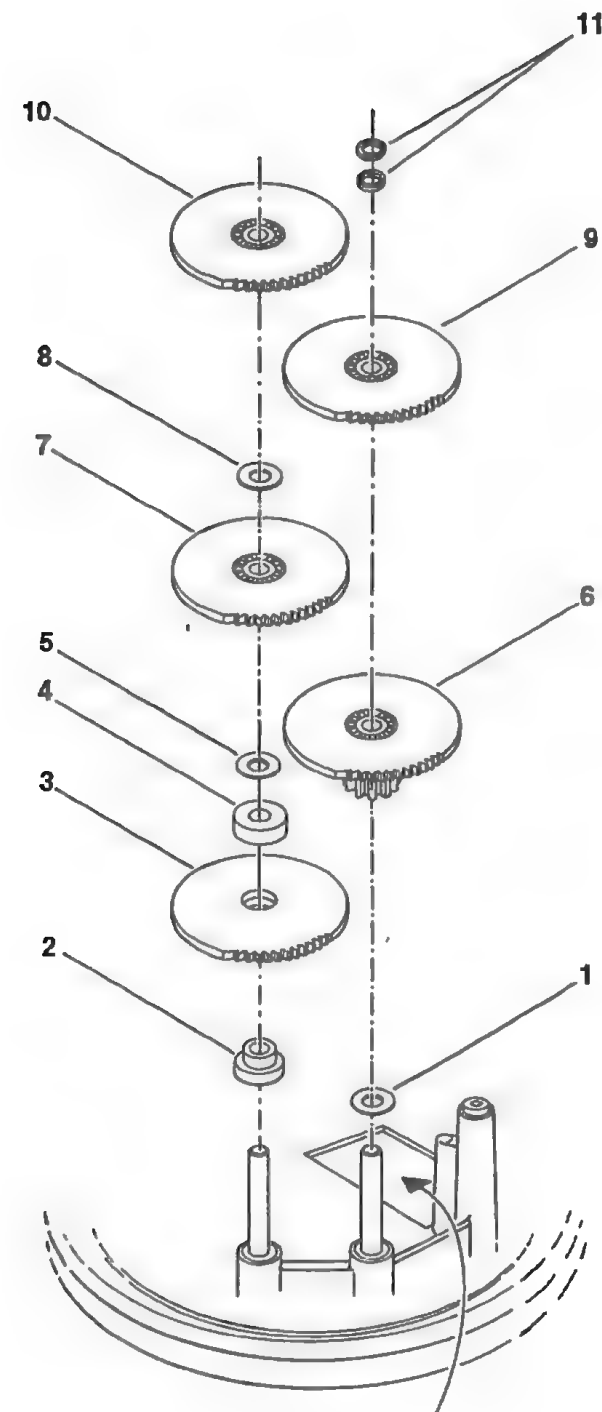
Section 10. Disassembly of the Rotator Unit

DISASSEMBLY OF THE ROTATOR

In order to service the rotator, the unit must be disassembled. We recommend the following procedure:

1. Set the rotator on a flat surface.
2. Remove the four (4) screws and carefully raise the top casting to expose the potentiometer and drive mechanism.
3. Carefully remove upper ball bearing retaining ring. Keep it circular and lay it on clean paper.
4. See that the potentiometer strip is clean and not burned at either end and that the arm is clean at the point of contact. Use only fine rouge cloth to polish the contact arm.
5. If the drive ring happens to be near the end of rotation, hold the unit horizontal, operate the spur gear to rotate the mechanical stop on the drive ring away from the area of the limit switch. See that the mechanical stop lever (which is positioned between the two limit switches) will open each electrical contact before it hits the corresponding mechanical stop. Also, see that the stop lever has not been deformed and that the electrical contacts are clean and uncorroded.
Rotate the top spur gear several revolutions to determine that the motor and its bearings are operating freely. Look for broken teeth in any of the gears.
6. Lift the motor and brake mechanism out of the brake housing. Carefully remove the ball bearing retainer and place it on a clean piece of paper.
7. Remove the ring gear from the motor base. This is accomplished by first pulling up on the side opposite the gear train. Then raise the entire ring slightly upward with the side away from the gear train so that it will slide out from under the gears.
8. Examine the teeth in the brake casting. Examine closely for evidence of broken or worn teeth.
9. To remove the potentiometer, remove the hex nuts and unsolder the leads. The mounting studs are integral to the motor and bell. In replacing the pot, be sure the connections are on the side which overhangs the motor.
10. To replace the motor, first remove the pot per step 9, then unsolder the black motor lead from the solder lug, the red lead from the inside left limit switch lug and the blue lead from inside the right switch lug. The fastenings holding the motor on the studs may then be removed and the motor pulled up and out. In replacing a motor, be sure to see that the round hole in the motor is next to the limit switch. Use a double locknut on this stud near the limit switch to provide clearance for the leads. Use special internal/external lockwasher over the stud that works in the slotted hole in the motor. Be sure that the pinion is snug against the spur gear before tightening this fastener over the slot.

SPUR GEAR ASSEMBLY



**PLACE THE OPENING
FOR ELECTRICAL LEADS TO
THE RIGHT.**

Figure 13
Spur Gear Assembly

The numbers within circles on this illustration are sequence-of-assembly numbers; their only function is to indicate which part should be positioned on the gear shaft in a particular sequence.

Item Numbers are used to identify a particular item by Part Number and Description. The Item Numbers listed correspond to the Item Numbers used in the Rotator Parts List in the rear of the manual.

Sequence Numbers 7, 9, and 10 (PN 5011200-1) are identical spur gears with rather small pinion gears attached to the bottom side.

Sequence Number 6 (PN 5011100-1) is a spur gear with a rather long pinion gear attached to the bottom side.

Sequence Number 3 consists of two (2) spur gears (PN 5010700-1) "sandwiched" together. There is no pinion gear on this spur gear.

Sequence Numbers 1 and 8 are identical flat washers.

The pinion gears for this application are always orientated on the shafts with the pinion gear side "down".

When assembling the gears and their associated components on both shafts, follow the numerical sequence shown.

Sequence No.	Item No.	Part Number	Description
1	111	5112000	Flatwasher
2	113	5037900	Bushing
3	112	5010700-1	Spur Gear
4	110	5037800	Spacer
5	138	5112100	Flatwasher, brass
6	108	5011100-1	Gear & Pinion Assembly
7	107	5011200-1	Gear & Pinion Assembly
8	111	5112000	Flatwasher
9	107	5011200-1	Gear & Pinion Assembly
10	107	5011200-1	Gear & Pinion Assembly
11	109	560084	Spacer, small gear

Section 11. Reassembly of the Rotator

REASSEMBLY OF THE ROTATOR

It is assumed in the following instructions that the brake mechanism is assembled and operative. The motor and gear train along with the potentiometer and the limit switches are likewise assembled, wired and operative.

It is not likely that the brake wedge will be exactly positioned in relation to the teeth in the brake housing to permit proper assembly unless the brake mechanism is retracted. For this reason, it is necessary to operate the brake mechanism electrically during Step 8 of the assembly of the rotator unit.

1. See that a small amount of low temperature, high quality, light weight grease is conservatively distributed around the ball bearings, ring gear and spur gears. Only an even film of grease is desirable (approximately one thimbleful of grease should be used to lubricate a completely dry rotator). Excessive grease will only run out during high temperatures or cause power loss during low temperatures.
2. Rotate the upper spur gear until the inwardly protruding mechanical stop on the ring gear touches the channel shaped stop lever. This action will push it far enough to the left to just open the left hand limit switch contact (it is assumed that the rotator is viewed from the side of the limit switch). This situation represents the extreme clockwise end of rotation. The potentiometer arm must then be rotated to its extreme clockwise position against the top stop.
3. Secure the upper bell housing upside down by the mast support in a vise with the open end of the "V" toward the bench. The boss, which drives the potentiometer arm that is located in the bottom part of the housing, will then be to the left of center.
4. Clean the inner portion of the housing and apply a small amount of grease to the ball race. Then, carefully insert one ball bearing assembly with the fringed rim up and against the outer edge of the casting.
5. Grasp the operating mechanism by the flat base, steady the ring gear, invert the mechanism and lower it into the housing. In doing this, note that the serrated portion of the potentiometer arm must engage the driving boss in the housing and that the three driving bosses on the ring gear must engage into the mating recesses in the top housing. This situation will result automatically if the previous instructions have been followed.
6. Clean the exposed bearing race and apply a film of grease. Then apply the top bearing assembly to the race with the rim downward.
7. Clean the brake housing. Lower the brake housing into place so that the assembly holes will approximately line up with the threaded holes in the bell housing. **Do not mechanically force an exact alignment of these holes without electrically retracting the brake mechanism.**
8. Connect control unit pins 1 and 2 only to the corresponding pins on the rotator while it remains clamped in the vise. Momentarily operate the "Brake Release". This will permit the brake housing to freely rotate the exact alignment of the holes. With the brake retracted, secure the upper mast support (bell) to the lower brake housing. Tighten finger tight. With the brake retracted, tighten all four (4) bolts in an alternate pattern to approximately 85 inch-pounds of torque. Recheck the brake to make sure that it operates freely.

It is suggested that all eight wires be connected from the control box while the rotator is still on the bench and that its complete operation be checked.

Section 12. T2X Rotator Replacement Parts

ITEM NO.	PART NO.	DESCRIPTION	QTY
101	5137701	Rotator with connector.....	1
102	5136201	Upper Mast support (Bell Casting)	1
103	5136301	Brake Housing	1
104	5033501	Ball Bearings (Unit 1).....	98
		Ball Bearings (Unit 2)	40
105	5011300	Bearing Retainer (Unit 1)	1
		Bearing Retainer (Unit 2)	1
106	5136401	Casting, Brake Support	1
107	5011200	Gear and Pinion	3
108	5011100	Gear and Pinion	1
109	560084	Spacer, Small Gear	1
110	5037800	Spacer, Large Gear	1
111	5112000	Washer	3
112	5010700	Gear, Final Spur	2
113	5037900	Bushing, Gear	1
114	5136101	Gear, High-Strength Drive (Ring Gear).....	1
115	5037000	Base Casting and Gear Shaft Assembly	1
116	5012200	Plate, Motor Mounting	1
117	5137600	Motor and Pinion (brass).....	1
118	5023100	Potentiometer	1
119	5009900	Solenoid (Brake)	1
120	5010401	Latch, Brake	1
121	5010500	Spring, Latch.....	2
122	5010600	Pin, Latch	2
123	5028204	Retainer, Latch Pin.....	2
124	5011400	Spring, Extension	2
125	5009800	Links, Connecting	2
126	380626	Pin, Connecting Link	1
127	350885	Washer, Connecting Link	1
128	5151401	Wedge, Brake.....	1
129	5011700	Support, Brake Wedge	1
130	5010000	Pin, Solenoid	1
131	5010101	Spacer, Solenoid	3
132	5028206	Pin, Retaining.....	2
133	179894	Mounting plate, drilled.....	1
134	510680	Screw, #6 x 3/8", torx	2
135	509711	Bolt, 5/16-18 x 2", Hex Head, SS	6
136	555747	Nut, Hex, 5/16"-18, SS	6
137	564792	Lockwasher, Split, 5/16", SS	6
138	450590	Strain relief, Heyco	1
139	610215	Cable, 2 # 16, 6 # 18	A/R
140	5149600	Bolt, Hex Head, 5/16"-18 x 1 5/8", SS	6
141	650179	Receptacle, AMP	1
142	5147800	Nut, Hex, 5/16"-18, SS	5
143	567115	Lockwasher, Split, 1/4"	11

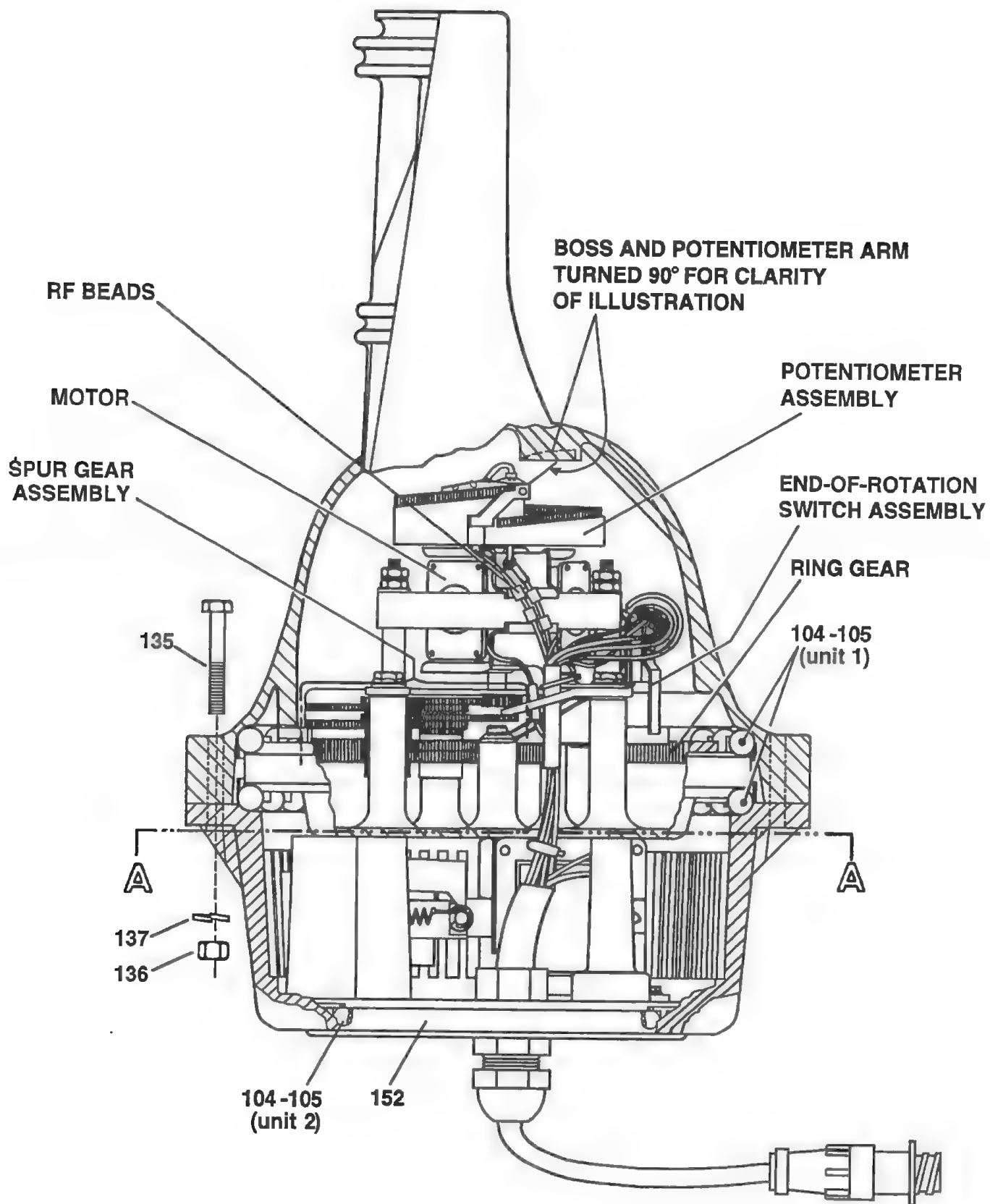


Figure 14
Inside View of T2X Rotator

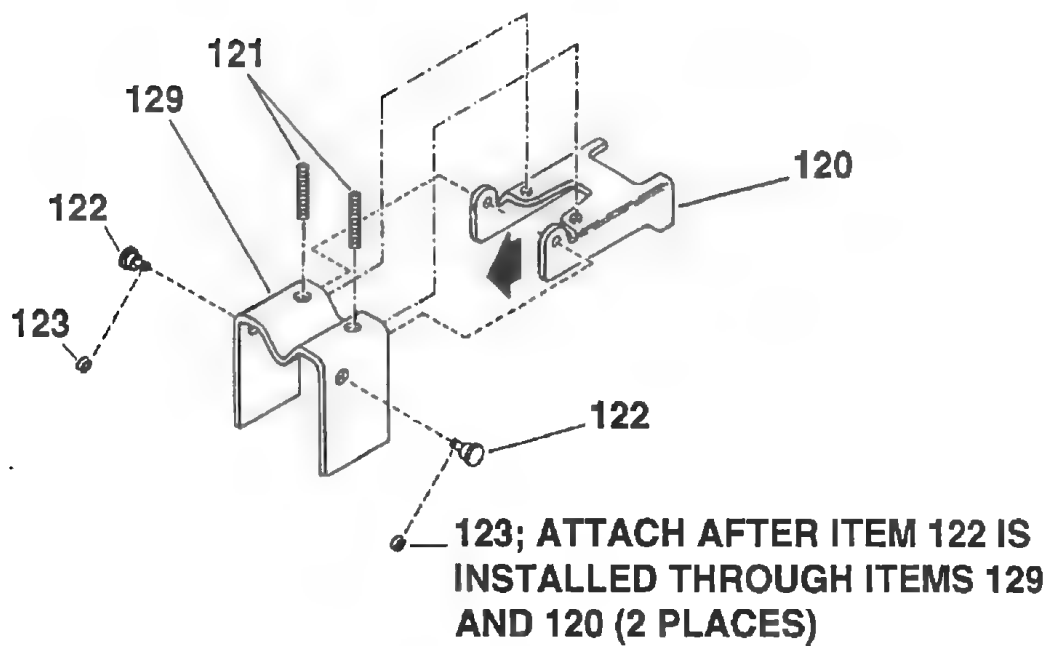
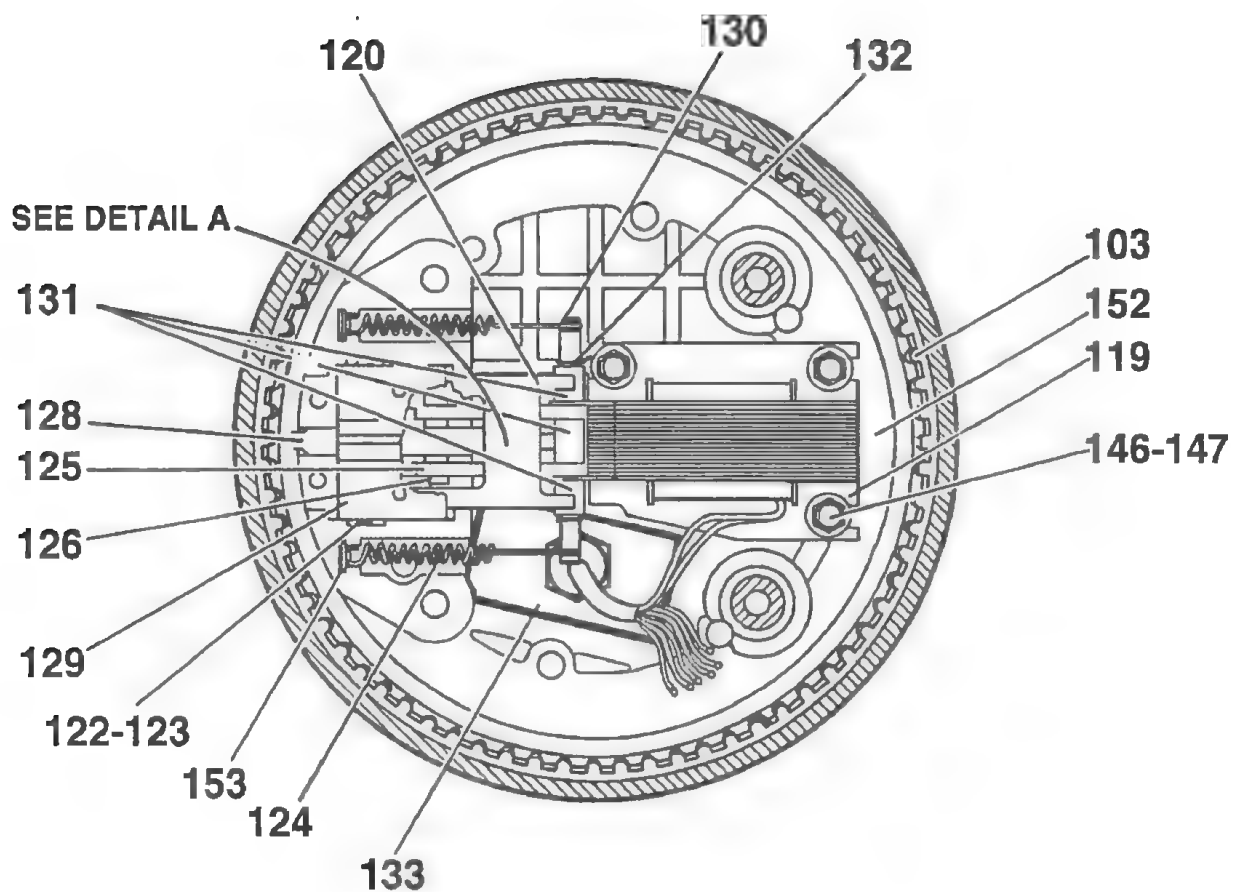


Figure 15
Brake Assembly Detail

T²X Rotator Replacement Parts (Continued)

ITEM NO.	PART NO.	DESCRIPTION	QTY
144	650291	Contact, AMP	8
145	5112300	Flatwasher, 3/8"	3
146	5112200	Flatwasher, 3/16"	4
147	5105600	Screw, Thread Cutting, #10-24 x 1/2"	6
148	5104700	Lockwasher, Internal/External #8	1
149	5067000	Arm, Pivot.....	1
150	5113100	Nut, Hex, #6-32.....	2
151	556990	Nut, Hex, #8-32.....	4
152	5136401	Casting, Break Support	1
153	5009600	Clamp, Spring	2
154	567115	Lockwasher, Split, 1/4"	4
155	120006001	Lockwasher, External, #6.....	2
156	567135	Lockwasher, Internal, #8.....	3
157	102720521	Screw, 1/4"-20 x 3 1/4"	4
158	5146110	Assembly, End Of Rotation	1
159	5031100	Lug, Solder.....	2
	5142210	Kit, Accessory.....	1
160	5137000	Plate, Mast Clamp	1
161	5136900	U-Bolt, 5/16"-18 x 3 1/4" x 4"	2
140	5149600	Bolt, Hex Head, 5/16"-18 x 1 5/8", SS	6
162	5142400	Bolt, Hex Head, 5/16"-18 x 3 1/2", SS	1
136	555747	Nut, Hex, 5/16"-18, SS	5
137	564792	Lockwasher, Split, 5/16", SS	11
	870598	Parts Pack, Connector	1
163	650181	Plug, 9 pin	1
164	650180	Receptacle shell.....	1
165	650293	Contact	8
166	640077	Plug, 8 pin	1
167	890014	Ferrite bead, Type 73	4
168		Grease, Special Kit (Quantity for one overhaul).....	1

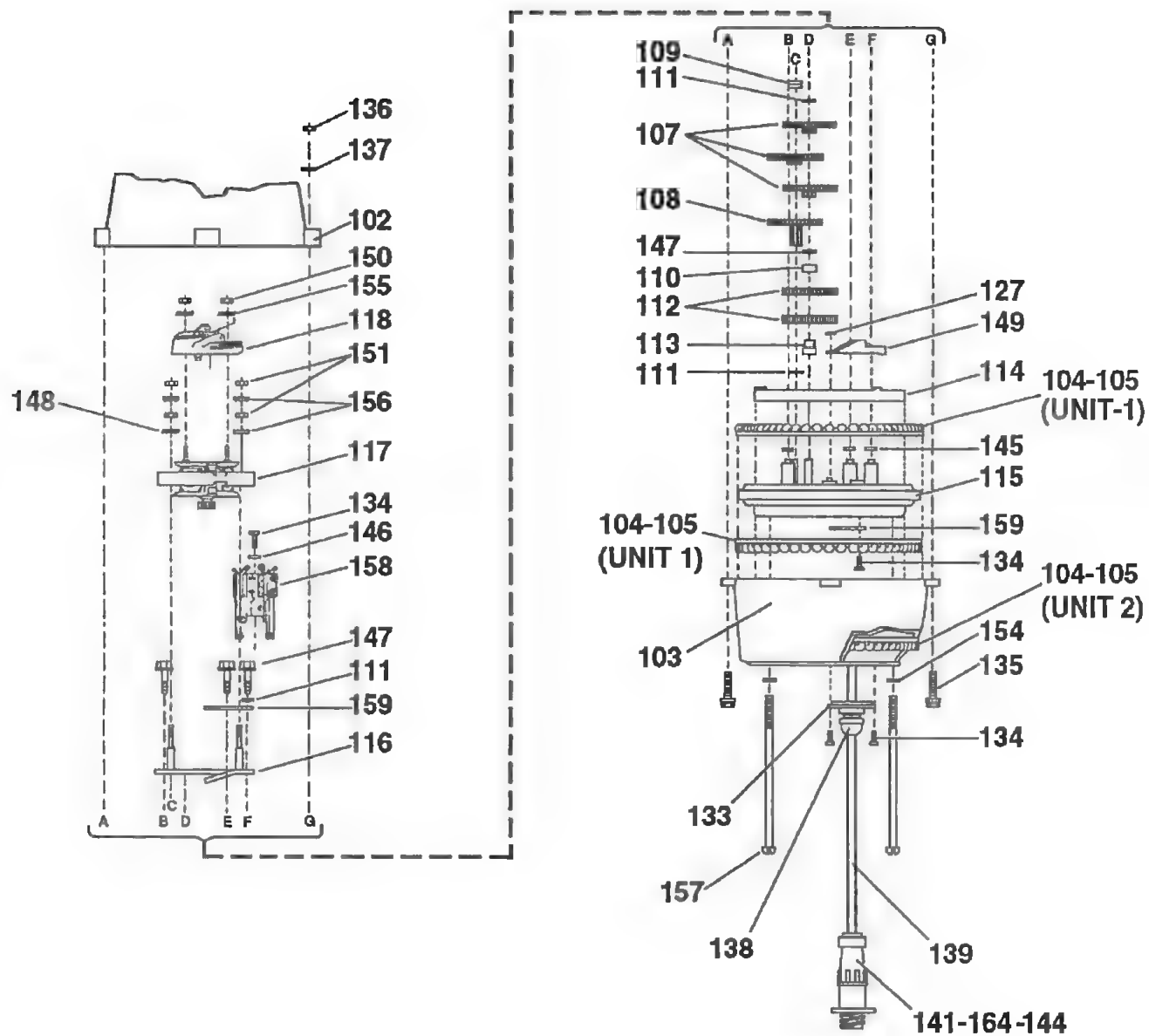


Figure 16
T2X Rotator - Illustrated Parts Breakdown

Section 13. DCU-1 Control Unit Block Diagrams

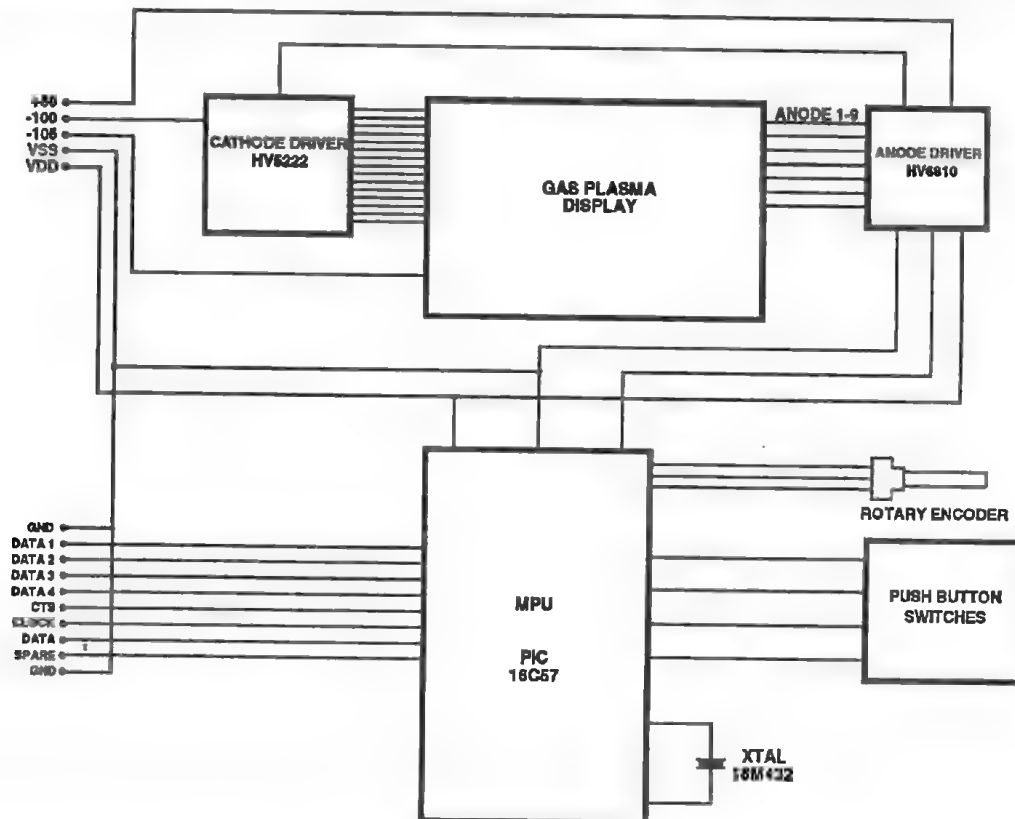


Figure 17
Front Panel PCB

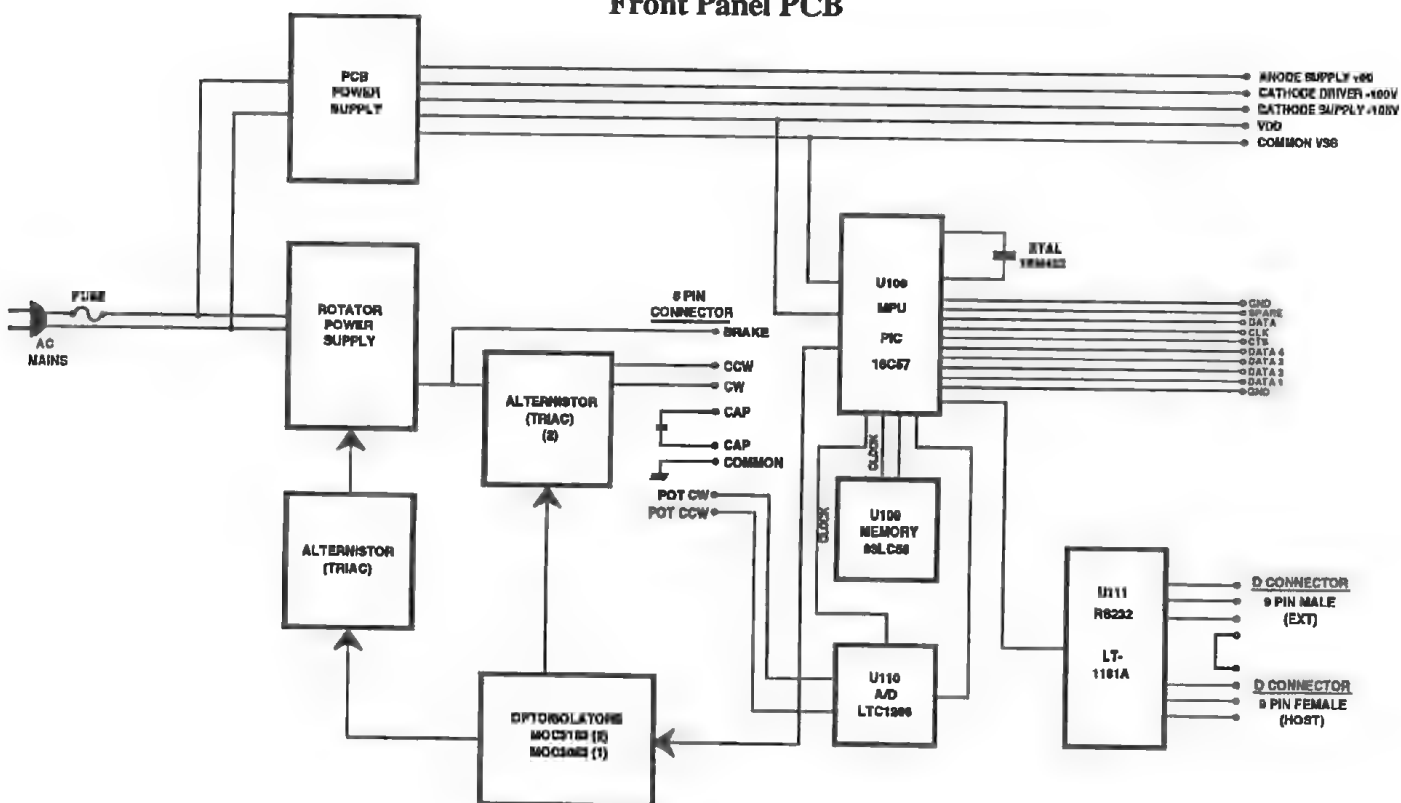


Figure 18
Control PCB and External Components

Section 14. DCU-1 Control Unit Replacement Parts List

Item No.	Part No.	Description	Qty
	870804	DCU-1 Assembly, 120 V.....	1
	870842	DCU-1 Assembly, 220 V.....	1
	1034403	Fuse 3 Amp 3 AG (120 VAC).....	1
	(710053)	Fuse 1 AMP 5 x 20 mm (220 VAC).....	1
	1056300	Fuse Holder (120 VAC).....	1
	(710054)	Fuse Holder 5/20 mm (220 VAC).....	1
	105632051	6-32 x 5/16 screw.....	2
	150078	Front overlay, printed.....	1
	150624-3	Label, "TELEX".....	1
	171131	Spacer, transformer assy.	4
	350979	Clip, capacitor.....	1
	450431	Strain Relief (120 VAC).....	1
	(450403)	Strain Relief (220 VAC).....	1
	450433	Hole plug (110 VAC only)	1
	450614	Filter Display, printed.....	1
	470677	Backing plate, switch.....	3
	46002 RD	Connector, 2 pin, red.....	2
	47138P2	Contact, connector.....	4
	500157	Screw, 10-24 x 2".....	4
	500326	Screw, 4-40 x 5/16".....	7
	5022500	Terminal, solder.....	1
	506325	Screw, 1/4"-20 x 3/4".....	1
	5086100	Power Cord (120 VAC).....	1
	(5079800)	Power Cord (220 VAC).....	1
	5112400	Flat Washer .128 I.D.....	1
	5113100	Nut, 6-32, hex.....	5
	5141100	Rotator Housing, Top cover.....	1
	5141200	Rotator Housing, bottom cover.....	1
	5151501	Capacitor 130-156 MFD.....	1
	5152700	Bumper (rubber feet).....	4
	520057	Screw, 6-32 x 3/8", (black).....	8
	53432116	Knob.....	1
	53433015	Knob-cap.....	1
	550029	Wing nut, 1/4"-20.....	1
	554071	Nut, 10-24, hex.....	8
	556960	Nut, 1/4"-20, hex.....	1
	567110	Lockwasher, 1/4", internal.....	2
	567120	Flat washer, 1/4".....	2
	567125	Lockwasher, No. 10, internal.....	8
	640076	Socket, 8 pin (Part of 870849 Wire Assembly).....	1
	640084	Cable Assembly, 10 wire, 7 inch.....	1
	640085	Cable Assembly, 6 wire, 7 inch.....	1
	810138	Key pad, 3 button.....	3
	51401-031	Screw, 4-40 x 1/4", socket head.....	3

DCU-1 Control Unit Replacement Parts List (continued)

Item No.	Part No.	Description	Qty
	870806	Transformer Assembly, (120 VAC).....	1
	1073501	Transformer Assembly, (220 VAC).....	1
	870807	PCB Assembly, front panel.....	1
	870808	PCB Assembly, control.....	1
	8800102114	Connector D, 9 pin, male (Part of 870848 Wire Assembly).....	1
	8800102132	Connector D, 9 pin, female (Part of 870848 Wire Assembly).....	1
	8800102463	Hardware , D Connector	2
	880394	Chassis, Assembly	1

Section 15. Parts-Pack Parts List

Accessory Kit PN 5142210

Item No.	Part No.	Description	Qty
147	110820035	1/4"-20 x 1 1/4 Hex.....	5
144	5011500	Mast Clamp.....	1
145	5038200	U-type Bolt.....	3
145	5050200	Flatwasher.....	4
148	554099	1/4"-20 hex nut.....	5
149	561177	1/4", split lockwasher.....	9

Connector Parts Pack PN 870598

Item No.	Part No.	Description	Qty
176	650181	Plug, Amp	1
177	650180	Shell, Amp	1
178	650293	Contact, socket.....	8
179	640077	Plug, 8 pin	1

DCU-1 Parts Pack, 120V, 870805

Item No.	Part No.	Description	Qty
	1034403	Fuse, 3 AMP, 3 AG.....	2
	640077	Plug, 8 pin	1
	870844	DCU Termination Assembly	1

DCU-1 Parts Pack, 220V, 870843

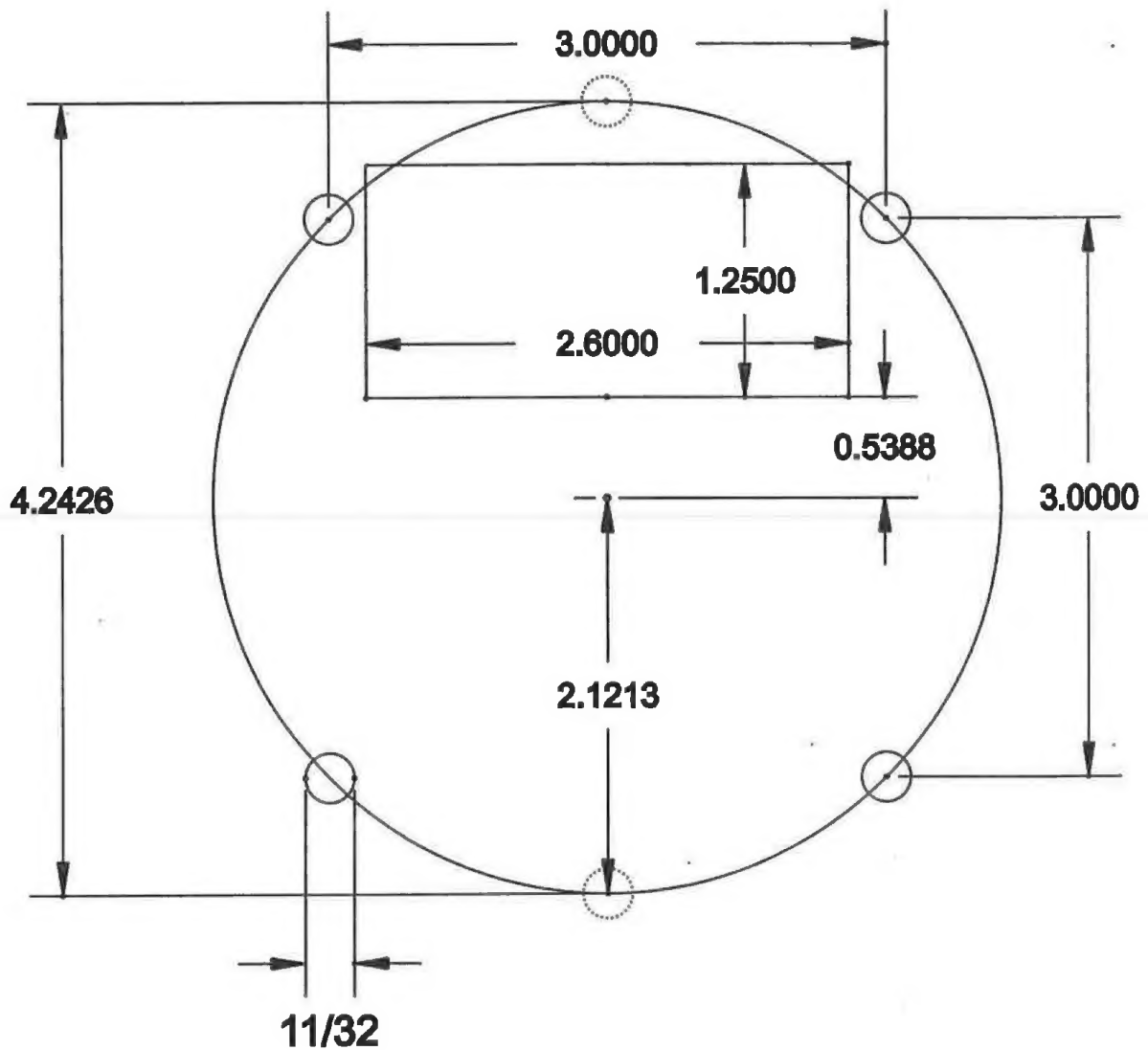
Item No.	Part No.	Description	Qty
	710053	Fuse, 1 AMP, 5 x 20 mm	2
	640077	Plug, 8 pin	1
	870844	DCU Termination Assembly (plug).....	1

***hy-gain*® LIMITED WARRANTY**

hy-gain Warrants to the original owner of this product, if manufactured by *hy-gain* and purchased from an authorized dealer or directly from *hy-gain* to be free from defects in material and workmanship for a period of 12 months for rotator products and 24 months for antenna products from date of purchase provided the following terms of this warranty are satisfied.

1. The purchaser must retain the dated proof-of-purchase (bill of sale, canceled check, credit card or money order receipt, etc.) describing the product to establish the validity of the warranty claim and submit the original or machine reproduction of such proof-of-purchase to *hy-gain* at the time of warranty service. *hy-gain* shall have the discretion to deny warranty without dated proof-of-purchase. Any evidence of alteration, erasure, or forgery shall be cause to void any and all warranty terms immediately.
2. *hy-gain* agrees to repair or replace at *hy-gain*'s option without charge to the original owner any defective product under warranty, provided the product is returned postage prepaid to *hy-gain* with a personal check, cashiers check, or money order for \$8.00 covering postage and handling.
3. Under no circumstances is *hy-gain* liable for consequential damages to person or property by the use of any *hy-gain* products.
4. Out-of-warranty Service: *hy-gain* will repair any out-of-warranty product provided the unit is shipped prepaid. All repaired units will be shipped COD to the owner. Repair charges will be added to the COD fee unless other arrangements are made.
5. This warranty is given in lieu of any other warranty expressed or implied.
6. *hy-gain* reserves the right to make changes or improvements in design or manufacture without incurring any obligation to install such changes upon any of the products previously manufactured.
7. All *hy-gain* products to be serviced in-warranty or out-of-warranty should be addressed to ***hy-gain*, 308 Industrial Park Road, Starkville, Mississippi 39759, USA** and must be accompanied by a letter describing the problem in detail along with a copy of your dated proof-of-purchase.
8. This warranty gives you specific rights, and you may also have other rights which vary from state to state.

CLEARANCE HOLES TO BE 11/32"



Tower Drilling Template

This information is believed correct, but no warranty is given or implied and no liability is assumed by Hy-Gain as to its accuracy or completeness. Changes may be made from time to time so that the user should verify all factors that may be critical. This information is not to be construed as authorizing or advising use of any patented invention.

hy-gain.

**308 Industrial Park Rd.
Starkville, MS. 39759 USA
PH: 662-323-9538 FAX: 662-323-6551**